Supporting Materials

California Education and the Environment Initiative

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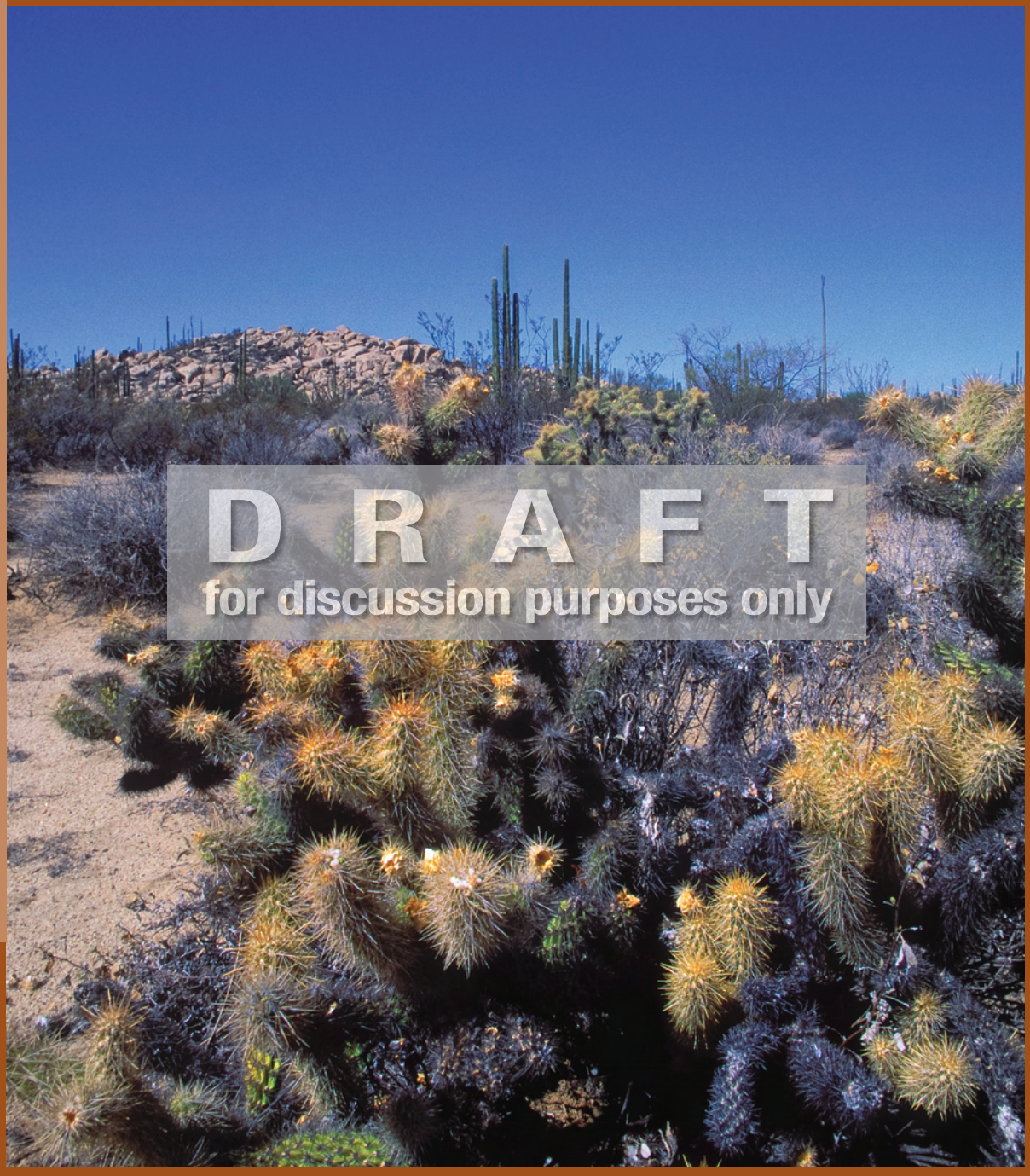
Earth Science Standard E.5.e.



Rainforests and Deserts: Distribution, Uses, and Human Influences

D R A F T
for discussion purposes only

California Education and the Environment Initiative

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Contents

Assessments

Rainforests and Deserts: Distribution, Uses, and Human Influences—Traditional Unit Assessment Master 4

Uses and Human Influences on the Distribution of Rainforests—Alternative Unit Assessment Master 8

Lesson 1 California's Desert Blooms

Activity Masters

Key Unit Vocabulary 11

California Connections: The California Desert Protection Act—A National Success 13

Managing Human Activity in the Desert 17

Visual Aids

1 Joshua Tree National Park 18

2 Barstow-Vegas Wagon Trail 19

Lesson 2 Global Distribution of Rainforests and Deserts

Activity Masters

World Rainforests and Deserts 20

Visual Aids

3 Life in the Amazon Rainforest 22

4 Life in the Mojave Desert 23

5 Latitude 24

6 Global Convection Currents 25

7 Global Distribution of Rainforests 26

8 Global Distribution of Deserts 27

Lesson 3 Rainforests' and Deserts' Influence on Humans

Activity Masters

Importance of Rainforests to Human Lives 28

Importance of Deserts to Human Lives 30

Rainforest Uses 32

Desert Uses 34

Visual Aids

9 Rainforest and Desert Goods 36

10 Solar and Wind Power from the Desert 37

11 Global Population Density 38

12 Rainforest Uses 39

13 Deserts Uses 40

Lesson 4 Human Influences on the Distribution of Rainforests and Deserts

Activity Masters

Human Uses and Effects on Deserts and Rainforests 41

Visual Aids

14 Human Activities in Rainforests 44

15 Border Between Haiti and Dominican Republic 45

16 Human Activities in Deserts 46

17 World Biomes 47

18 Ecosystem Recovery 48

19 Global Desertification Vulnerability Map 49

Lesson 5 The Effects of Ecosystem Distribution on Human Cultures

Global Climate Change-The Green Sahara 50

Geographic Distribution of Biomes and Effects on Humans 52

Visual Aids

20 Changing Boundaries of the Sahara Desert 54

21 Artifacts of the Kiffian Culture 55

22 Global Temperature Change over the Past 18,000 Years 56

23 Artifacts of the Tenerian Culture 57

24 The Anasazi 58

25 Scientific Evidence of Ancient Climates 59

Lesson 6 Science and Decision-making for California's Deserts

Activity Masters

Recoverability and Vulnerability of Desert Ecosystems 60

Vulnerability of Desert Ecosystems Guiding Questions 64

Visual Aids

26 Mojave Desert Ecosystem 67

27 Who Manages California's Mojave Desert Lands? 68

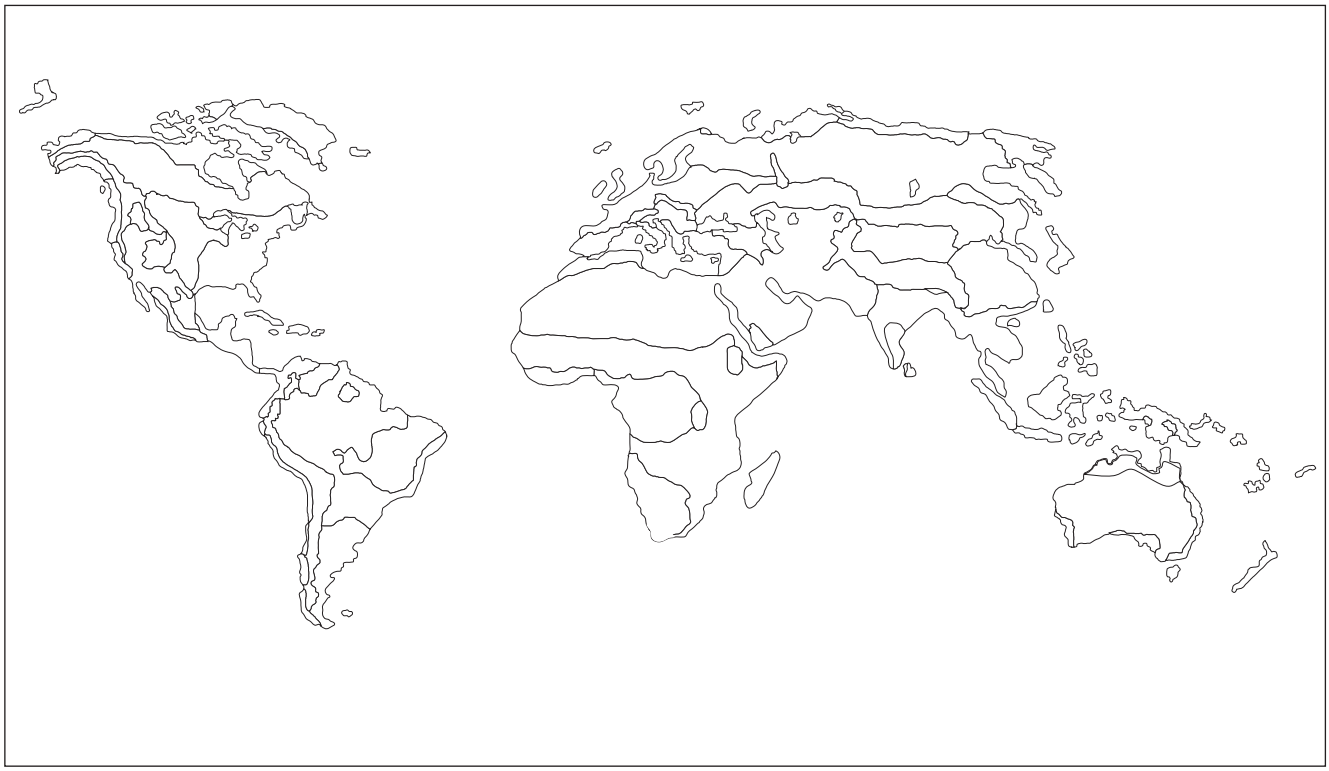
28 Desert Crusts 69

29 Spatial Map for Soil Compaction Recovery 70

Name: _____

Part 1: Mapping Exercise:

1. On the map below, identify and label (use the letter of the corresponding phrase) the following areas (2 points each):
   a. The latitudinal band where tropical rainforests are found.
   b. "Tropic of Capricorn" and "Tropic of Cancer."
   c. A tropical rainforest
   d. Deserts on two continents



Part 2: Multiple Choice: Select the best answer and circle the correct letter. (2 points each)

1. A physical property that defines a desert is:
   a. mild temperatures
   b. a specific longitude
   c. low amount of precipitation
   d. many cacti

2. Which best represents the conventional definition of a biome such as desert or rainforest?
   a. function of climate and geography
   b. function of human activity
   c. function of map companies
   d. function of legal system

Name: _____

3. Which of the following locations has a tropical rainforest?
   a. Costa Rica
   b. Sitka, Alaska
   c. Patagonia
   d. Green Sahara

4. The one physical property that best defines a rainforest is:
   a. very low temperatures
   b. high amount of precipitation
   c. low biodiversity
   d. dominated by old growth vegetation

5. Land set aside because of its unique physical or cultural value, regulated for human activities by assigned agencies is called a:
   a. national park
   b. wilderness area
   c. preserve
   d. all of the above

6. Which of the following practice(s) can change the local distribution (presence) of rainforests?
   a. mining
   b. logging resulting in deforestation
   c. agriculture
   d. all of the above

7. The California Desert Protection Act of 1994:
   a. was passed immediately and unanimously.
   b. established new national parks, wilderness areas, and preserves.
   c. was not opposed by off-road vehicle groups.
   d. is no longer valid.

8. Human practices significantly damage rainforest ecosystems in all of the following ways except:
   a. urban development.
   b. searching for pharmaceutical sources.
   c. flooding by building dams to provide power.
   d. erosion from mining.

Name: _____

9. Scientific knowledge provides _____ for policy and management decisions.
   a. long term monitoring data
   b. special interest group opinion
   c. legal status
   d. a biased approach

10. An example of an ecosystem service is:
    a. timber
    b. food
    c. decomposition of waste
    d. pharmaceuticals

Part 3: Short Answer (5 points each)

1. Identify two physical properties that define a tropical rainforest.

_____

_____

_____

2. Identify two physical properties that define a desert.

_____

_____

_____

_____

_____

3. Describe two human practices that contribute to destruction of rainforests.

_____

_____

_____

_____

_____

Name: _____

4. Define “desertification” and name two causes of desertification.

5. Explain why the tropics experience high levels of annual rainfall.

6. What evidence is there that the Sahara Desert once had lakes, forests, and ancient human cultures?

Name: _____

Directions: Read the bulleted items in the writing prompt. Write a 1–2 page essay (400 words) that answers each item in order. Use the entire class period.

Writing prompt:

- Describe the location and properties of tropical rainforests.
- Explain the importance of rainforests to human lives and communities.
- Identify factors that affect the geographic distribution of rainforests on Earth and provide examples of the human practices that can affect the local distribution (presence) of rainforests.
- Explain how changes to the geographic distribution of rainforests can influence humans, and human communities, economies and cultures.
- Describe the role of scientific knowledge in making policy and management decisions about human activity related to rainforest and desert ecosystems.

Name: _____

Name: _____

Abiotic: Pertaining to the non-living components or factors within or related to natural systems, such as soil, water, and temperature.

Ancient peoples: Humans who lived prior to recorded history.

Arid region: An area characterized by minimal precipitation, such as a hot desert, or precipitation that is locked in a solid form, such as a cold desert like Antarctica.

Biological control: The method of controlling pests and plant diseases that relies on predation, parasitism, or other natural mechanisms.

Biomass: The total mass of living matter in a given area.

Biome: A group of similar ecosystems defined by vegetation and climate, such as tundra, desert, or grasslands.

California Desert Protection Act: An act of Congress that protects the federally owned public lands of California's deserts to preserve their geologic and ecological features.

Climate: The prevailing weather conditions in a region over a long time period as influenced by temperature, precipitation, humidity, and other meteorological factors.

Compaction: The compression of soils by driving out air, such as by vehicle traffic, or footprints of humans or livestock.

Desertification: The conversion of semi-arid regions to desert as a result of human activity as well as climate change.

Drought: A long period of time with little or no precipitation.

Economy: All the ways goods or services are produced, distributed and obtained by individuals and businesses.

Ecosystem: A specific area, such as a desert, containing a characteristic set of interdependent species that interact with each other and the abiotic components found there.

Ecosystem goods: Tangible materials such as timber and food produced by natural systems that are essential to human life, economies, and cultures.

Ecosystem services: The functions and processes that take place in natural systems, such as pollination, that support or produce goods and help sustain human life, economies, and cultures.

Environmental Impact Report (EIR): An informational document that provides public agencies and the general public with detailed information about the effects that a proposed project is likely to have on the environment.

Environmental region: A geographical area that is defined by its distinct landforms, climate, and soils.

Geographic distribution: The locations on Earth where biomes, ecosystems, and species are found.

Human demographics: Selected population characteristics used in government or scientific research studies.

Indigenous (or native): Originating in a particular region or country.

Latitude: An angular measurement of locations on Earth to the north or south of the equator from 0° at the Equator to 90° at the Poles.

Local distribution (presence): The specific locations where ecosystems, habitats, and species are found.

National park: Land that is owned by a government and monitored for human activities by assigned agencies.

Natural resources: Materials and material capacities supplied by natural systems and used by humans (e.g., forests, water, and energy reserves).

Natural system: The interacting and/or interdependent components, processes, cycles, and interactions among organisms and their habitats.

Pharmaceuticals: (noun) Medicinal drugs.

Policies: Broad statements that define how groups or organizations achieve their goals and objectives.

Predictive modeling: A model that uses interacting variables to predict the probability or outcome of an action.

Preserve: A delineated area including geologic features and unique organisms that is protected and maintained.

Rain shadow: An area with reduced precipitation that lies on the leeward (downwind) side of a mountain.

Semi-arid region: An area characterized by annual average precipitation of 10–20 inches.

Spatial model: A map of variables over a geographic region.

Suburban development: The development of planned human communities that radiates from urban centers.

United States Geological Survey (USGS): A federal agency that provides reliable scientific information to describe and understand the Earth, and manage water, biological, energy and mineral resources.

Wilderness: Areas that have not yet been strongly influenced by human activities and are of special interest because of their unique ecosystems.

The California Desert Protection Act—A National Success

The passage of the California Desert Protection Act in 1994 was the culmination of a nine-year legal battle by conservationists seeking legislation to protect desert habitat in California and other parts of the American Southwest. The act survived four filibusters in the U.S. Senate, finally passing a day after the regularly scheduled adjournment date of the 103rd Congress, without a vote to spare.

Many people who drive through this area wonder what prompted conservationists to protect California's deserts. Those who know the region can tell you, it is an area rich with unique plants and animals, geological resources, and a place of great scenic beauty.

Joshua Tree National Park

California's Deserts

Deserts across Earth share some similarities but also exhibit individual characteristics that make them unique. Convective air patterns around Earth create geographic areas with similar climatic conditions at similar latitudes. Air masses rise at the Equator where the most light energy from the Sun is received per unit area of the Earth's

surface. That light energy is converted to heat, warming the air. As the air is warmed, its density decreases and it rises. As this rising air expands and cools, moisture within it is released, causing heavy rainfall and depleting the air of moisture. The cooled, moisture-depleted air finally sinks again near latitudes 30° north and south. Deserts are found beneath these bands of sinking, moisture-depleted air. Deserts comprise about one third of Earth's land surface.

The latitude of California's southern border is 32° north, exposing the region to the dry and warm air masses that produce desert conditions. Desert ecosystems cover one quarter of the state, primarily in the southeastern region. Twenty-five thousand square miles of California are occupied by the Great Basin, Mojave, and Sonoran Deserts. California's portion of the Sonoran Desert is called the Colorado Desert.

The California Desert Protection Act affected California's desert areas primarily in the Mojave Desert. The act created Death Valley National Park, expanding the protected area around the former Death Valley Natuional Monument. In addition, it created Joshua Tree National Park, and Mojave National Preserve, which encompasses not only the California portion of the desert but also 1,420,000 acres across the rest of the Southwest United States. The designation of national park status also protects and preserves the unrivaled scenic, geologic and wildlife values of these lands, perpetrates their significant and diverse ecosystems, and protects and preserves their historical and cultural values.

Preservation History

The story behind the unexpected success of the California Desert Protection Act began in the late 1960s with controversy over recreational land use. Photos of the Barstow-Vegas motorcycle race astonished the State Director of the Bureau of Land Management. Director Russ Penny saw that the damage caused by these off-road vehicles to desert vegetation and soils could lead to serious erosion. His concerns resulted in some of the earliest studies of deserts as unique and fragile ecosystems. Conservationists then began a public education program that included desert study trips to educate Californians about the value of these lands.

A law passed in 1976 required the Bureau of Land Management

Barstow-Vegas motorcycle race

to determine if any of its public lands should be set aside as wilderness. (Wilderness is defined as "an area where the Earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain.") The legislation also mandated preparation of a California Desert Plan. Over the next four years, there were open public debates on resource uses in California deserts. A compromise plan that considered mining, cattle grazing, recreation, as well as wilderness interests emerged at the end of the Carter administration in 1981.

But during the following Reagan years, the desert plan was gutted by amendments. No lands were set aside as wilderness despite the efforts of wilderness advocates. In 1986, California Senator Alan Cranston introduced the California Desert Protection Act. Senator Cranston continued to champion the act throughout its passage. From 1987 to 1993, California Senator Diane Feinstein introduced new versions of the act with each new Congress. Each version resolved new site-specific concerns of resource users such as ranchers and small mining operations. Other interests included agriculture, urban development, and military installations. These varied interests led to much dialogue and compromise as the act was developed.

Petroglyph

The strongest opposition to the act came from off-road vehicle groups whose activities inadvertently inspired the early desert conservation efforts. Despite delaying tactics by opponents, in 1994, the Senate stayed in session an extra day and the act received the votes required to pass. Millions of acres of desert wilderness areas and national parks were newly designated.

Why Fight for the Desert?

The lands protected by the act are located in an area rich in human and natural heritage. The lands include archaeological sites, homesteads, rock-walled military outposts, towering sand dunes, volcanic cinder cones, and stands of Joshua trees. The Environmental Impact Report produced to evaluate the consequences of implementing or failing to implement the act also documented fossilized dinosaur tracks, American Indian petroglyphs, abundant wildflowers, and several threatened and endangered species, including the desert bighorn sheep and desert tortoise.

Just as the Mojave Desert Preserve is abundant and beautiful, each park created within it by the act boasts unique splendor. Joshua Tree National Park encompasses parts of both the Mojave and

Colorado Deserts. It contains magnificent rock formations and spectacular plant life, from wildflowers on the desert floor to pine forests in the high country. The landscape of Death Valley National Park includes a diverse range of pine forests, salt playas, and jagged rocks. It is a land of extremes—one of the hottest, driest, and lowest places on Earth. Mojave National Preserve has equally remarkable geologic diversity—from limestone and granite to countless types of metamorphic rocks.

These wilderness areas offer an unequaled opportunity to experience vast areas of landscape and history that have been preserved and protected from human activity since the establishment of the act. The effects of land use and development can still threaten wilderness areas. Preservation of desert wilderness requires the highest levels of protection and management, as provided through the act.

Provisions of the Act

The purpose of the act was five-fold, to: (1) preserve natural values, (2) perpetuate ecosystems, (3) protect historical and cultural values, (4) provide opportunities for scientific research and recreation, and (5) promote public understanding. It transferred over 3 million acres of California desert from the Bureau of Land Management to the National Park Service. It designated nearly 8 million acres of wilderness areas. Nearly 10,000 acres of U.S. Forest Service lands and 9,000 acres of U.S. Fish and Wildlife Service lands were also set aside as wilderness.

President Clinton said, in signing the act in 1994, "This is the first time since 1980 that the United States has set aside so rich and vast an area… treasures that merit protection on behalf of the American people." Not everyone shared the enthusiasm or opinion of President Clinton about the act. Many business owners and residents remained defiant about the new restrictions. They considered it an unfair expansion of public lands at the expense of the rights and interests of private property owners. Yet there are those who deeply care for the desert's rich natural heritage and appreciate this wilderness as a place of solitude and a source of inspiration. They support the government's continued role in protecting these public lands, California's part of the global desert band.

Clouds over desert

Name: _____

Write complete sentences in response to the following prompts. (5 points each)

1. Identify four human practices that are detrimental to the desert ecosystem.

2. Identify how these practices cause problems.

3. Identify three agencies responsible for making desert management and policy decisions.

4. Identify three areas of science study that provide of scientific knowledge necessary to make appropriate management decisions.

5. Describe the purpose of an an environmental impact report.

Joshua Tree National Park

This photograph shows the landscape of Joshua Tree National Park. The Joshua tree (*Yucca brevifolia*) is the largest and most common plant in the park.

Barstow-Vegas Wagon Trail

Name: _____

Directions: Use your knowledge of latitude to locate the world's tropical rainforests and deserts. Color the rainforest biomes green and the desert biomes brown.

Summary Questions

Use the map above and what you have learned in class to answer the following questions. (25 points)

1. What is latitude?

_____

_____

_____

2. What are the general latitudes of the world's tropical rainforests?

_____

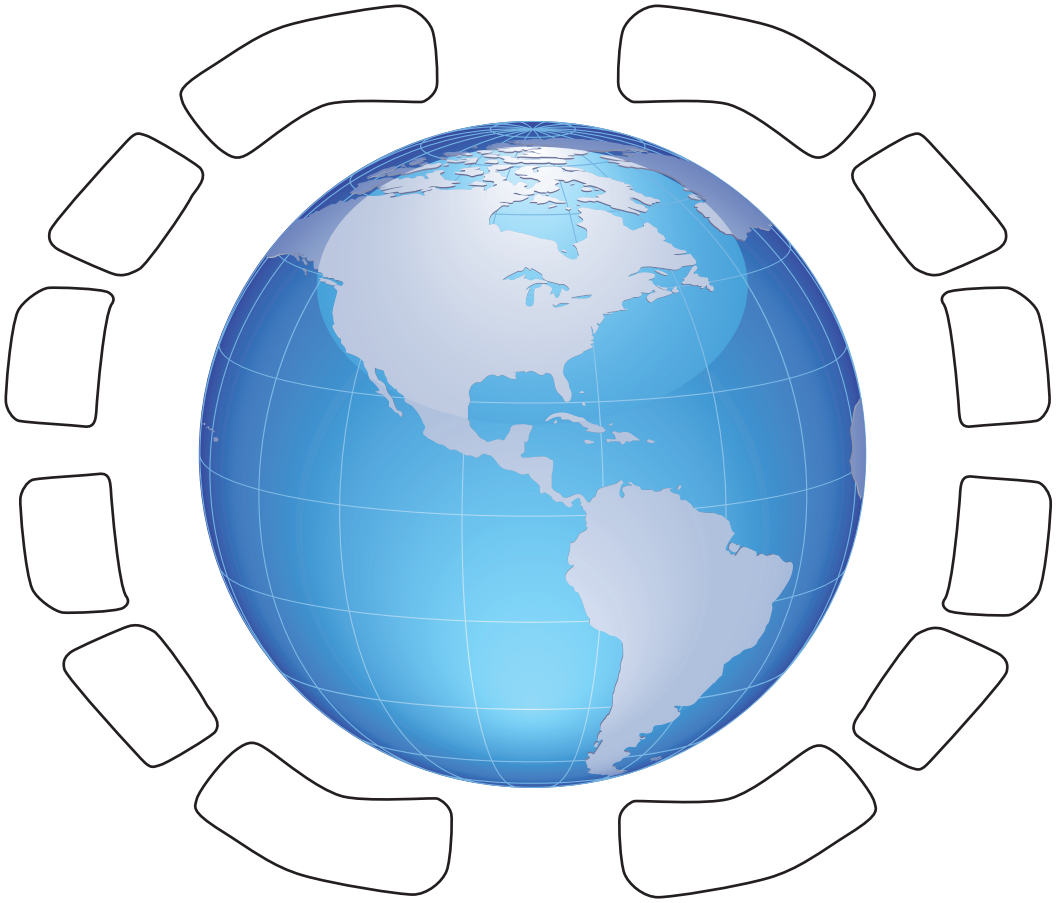
_____

Name: _____

3. Around what latitudes are the world's hot and arid deserts centered?

4. How do global convection currents and the resulting global climate patterns affect the geographic distribution of the world's desert and rainforest biomes?

5. On the diagram below, add arrows on the blank circulation cells to show how the air and moisture circulate in each of the latitudinal bands.

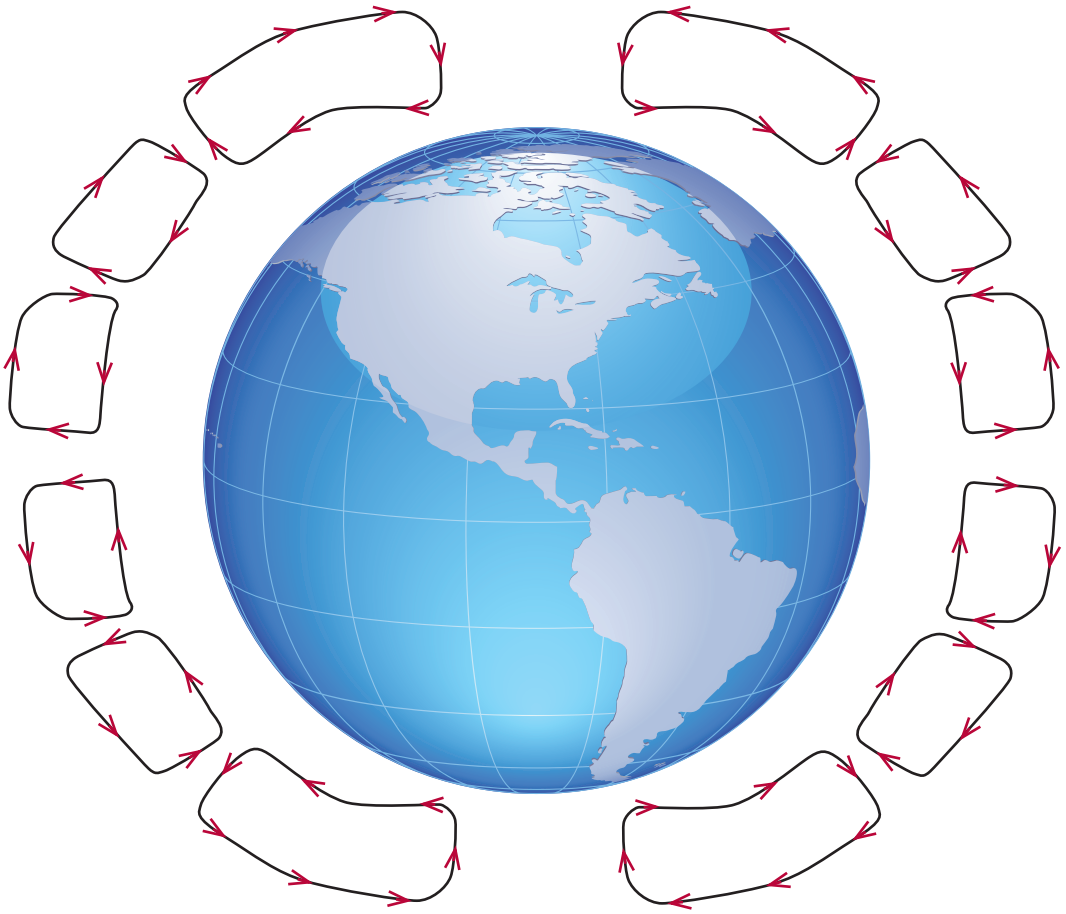


Life in the Amazon Rainforest

Life in the Mojave Desert

Latitude

Global Convection Currents



Global Distribution of Rainforests

Global Distribution of Deserts

Name: _____

Importance of Rainforests to Human Lives

The rainforest biome comprises a variety of ecosystems and although it occupies only about 7% of the land on Earth, it holds the highest biodiversity known on the planet and provides many ecosystem goods and services that are important to humans. Rainforests add water to the atmosphere through the process of transpiration which releases water from leaves during photosynthesis. This moisture contributes to the formation of rain clouds that release the water back on the rainforest. Most essential nutrients in rainforests are contained within living plants, dead wood, and decaying leaves (biomass).

Below are a few of the common goods that humans gain from rainforest ecosystems:

Trees for lumber

The removal of trees from rainforests has become a common practice over the last 200 years. The wood extracted from rainforests is used for making furniture and other hardwood products. There are many types of wood that have been critical in the development of human societies, such as teak, known for its durability when used in shipbuilding. Some woods, such as rosewood, mahogany, and many others have particular beauty and are used in furniture and ornaments. Ebony, a wood that is extremely dense and

Clearcut

Name: _____

Fruit and nuts

dark, has been traditionally used in piano keys. Grenadilla, another dark wood, has traditionally been used to make woodwind instruments such as the clarinet and oboe. While many traditional uses of exotic hardwoods found in rainforests have been replaced by plastics, there is still a great demand for the beautiful woods that are only found in these locations.

Foods and Spices from the Rainforest

Although fruits and vegetables can be gathered from rainforests by locals for food, the real value of the rainforest to the modern human diet is the diversity of plants that have been extracted for use in farming and agriculture. While it may be obvious that Brazil nuts are from the rainforest, so are macadamias, cashews, even peanuts. It might be surprising to know that potatoes, corn, and even rice were first found in rainforests. Chocolate, vanilla, cinnamon, coffee, and even sugar cane were first discovered in rainforests. Selected spices from the rainforests include ginger, black and cayenne pepper, nutmeg, and cloves.

The avocado, tomato, orange, lemon, grapefruit, and banana were discovered in rainforests. Add to the list figs, guavas, pineapples, passion fruit, and mangoes, but this is not the end. There are at least 3,000 fruits found in rainforests, and only about 200 of these are currently cultivated for human consumption. It is estimated that approximately 80% of the plant species cultivated for agriculture worldwide were discovered in rainforests. If there were no rainforests, some of the flavors people enjoy most would not exist.

Pharmaceuticals

The idea of finding medicines in plant species to cure human ailments is an old one. Hippocrates (400 BCE), generally acknowledged as the father of modern medicine, prescribed willow bark powder for fever, headaches, and joint pain. It was not until 1899 that the active ingredient in willow bark, salicylic acid, was patented and sold as Bayer Aspirin. So it was a natural step for modern scientists to look in the most species-diverse areas of the world, rainforests, for more medicines. Today, about 25% of Western pharmaceuticals are based on chemicals found in rainforest plants (and some animals). Astoundingly, only about 1% of the species found in rainforests have been screened for medically useful compounds. It is obvious there is a vast potential for finding new remedies and cures in the species found in the remaining rainforests. There is a parallel between pharmaceuticals and food source items found in the rainforest: there is so much yet to be discovered.

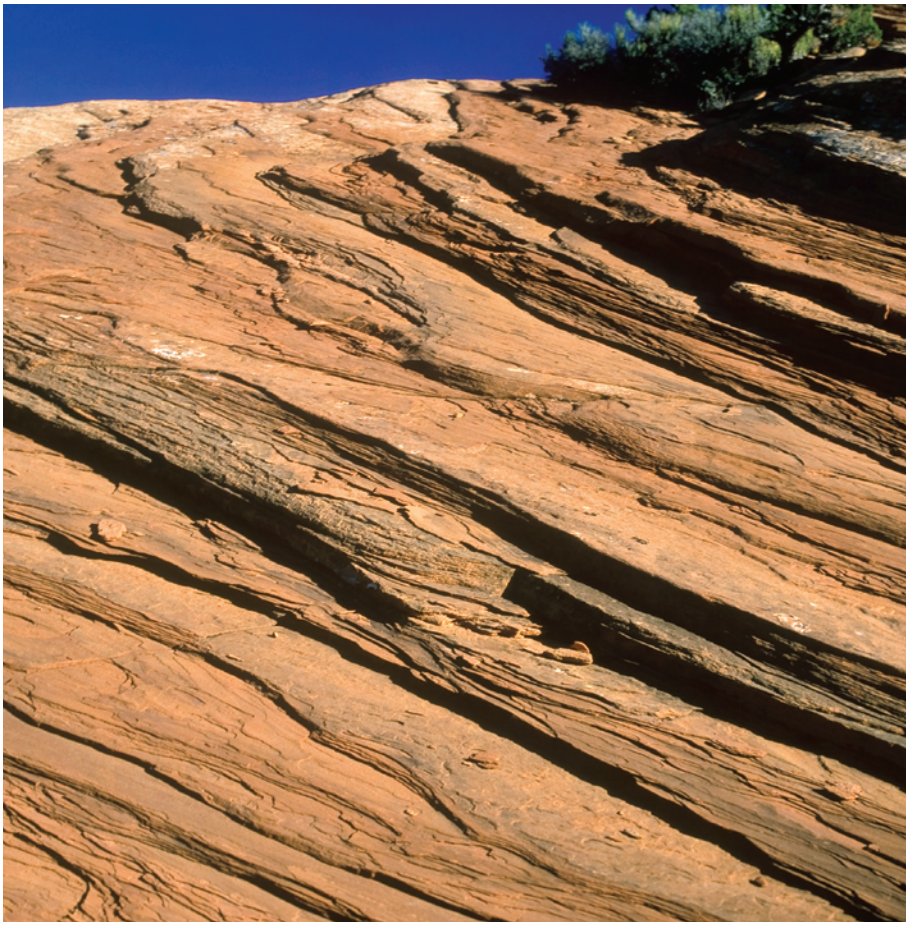
Name: _____

Importance of Deserts to Human Lives

Deserts are important biomes that occupy up to 30% of the land space on Earth. Human populations have long occupied desert habitats and have adapted to the arid environment. As the human population grows, we have discovered that deserts contain ecosystems important to the survival and wellbeing of our own species.

Human Uses of Desert Ecosystem Services and Goods

Indigenous peoples have occupied Earth's deserts for many thousands of years. They were able to gather everything they needed to survive from the areas that many other people and societies might consider barren lands. They hunted animals and harvested plants for food. They were most limited by the availability of water. The locations of their communities depended on what are often seasonal water sources like streams, springs, and waterholes. Many of the people who lived in deserts were nomadic, moving with the seasons to areas that offered game, plants, and water for themselves and their livestock. There are many natural resources found in deserts that are important to human communities. These resources include metal ores for lead, zinc, tungsten, copper, silver, gold, and over two thirds of Earth's crude oil. There are also many types of gemstones such as amethyst, jade, and



Sandstone

Name: _____

even diamonds. Rock from sandstone to marble is used for buildings. Although found in desert regions, these geological resources are not present because of desert conditions. Rather, they were formed deep in the Earth millions of years ago when the surface of the Earth looked quite different. Other useful minerals from desert regions have built up over long periods as water accumulated and evaporated. These minerals were carried by flowing water into large basin areas some of which were ancient lakes. As the water evaporated, the minerals were left behind and accumulated, forming unique mineral assemblages known as evaporates. These minerals, including gypsum, various salts, and borates are mined for human use. Deserts are also excellent sources of renewable energies from the wind and Sun. Deserts, on average, have the greatest amount of incoming solar radiation absorbed at the surface in the terrestrial world.

Gypsum

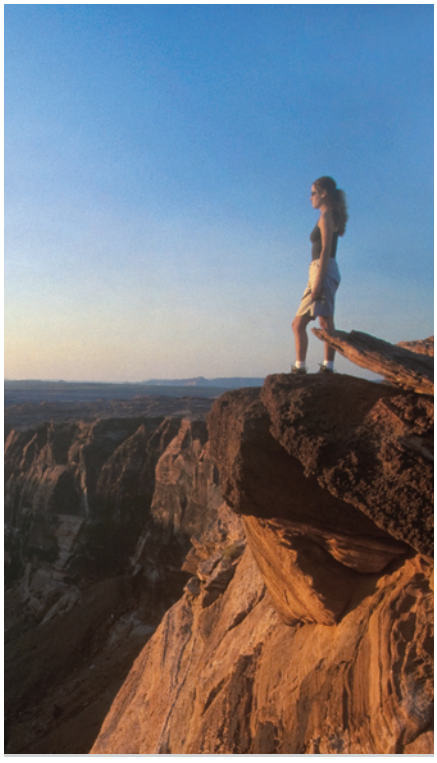
Soil and Water

For thousands of years, crops have been grown in desert soil with the aid of irrigation (mechanical watering systems). Furrows were dug between rows of plants, and water pumped from wells was allowed to run along the furrows. In modern times, dams and machinery are used to control the rivers and pump groundwater for irrigation. For example, to irrigate crops in Southern California's desert regions, like the Coachella Valley where Palm Springs is located, water is transferred from the Colorado River and delivered to local farms by the 122-mile (196 km) long Coachella Canal.

Using large quantities water for irrigation in desert regions has significant effects on soil. Salts already in the soil move to the soil surface by capillary action and accumulate there. This problem can be even more significant if the irrigation water also contains dissolved salts. In combination, these two factors can increase soil salinity and result in degradation of soils and vegetation.

Recreation

Deserts offer space and climate conditions for recreational activities such as hiking, camping, backpacking, rock climbing, and nature study.



Hiker in desert

Name: _____

Complete the chart below by listing at least five examples each for ecosystem goods, ecosystem services, and human uses related to rainforests.

Rainforests

Ecosystems Goods (5 points)

Ecosystems Services (5 points)

Human Uses (5 points)

Name: _____

Summary Question

Use **Rainforest Uses** to respond to the following writing prompt. (5 points)

Describe how a rainforest ecosystem is important to human lives and communities. Also, identify whether the ecosystem goods and services have local, regional, or global importance.

Name: _____

Complete the chart below by listing at least five examples each for ecosystem goods, ecosystem services, and human uses related to deserts.

Deserts

Ecosystems Goods (5 points)

Ecosystems Services (5 points)

Human Uses (5 points)

Name: _____

Summary Question

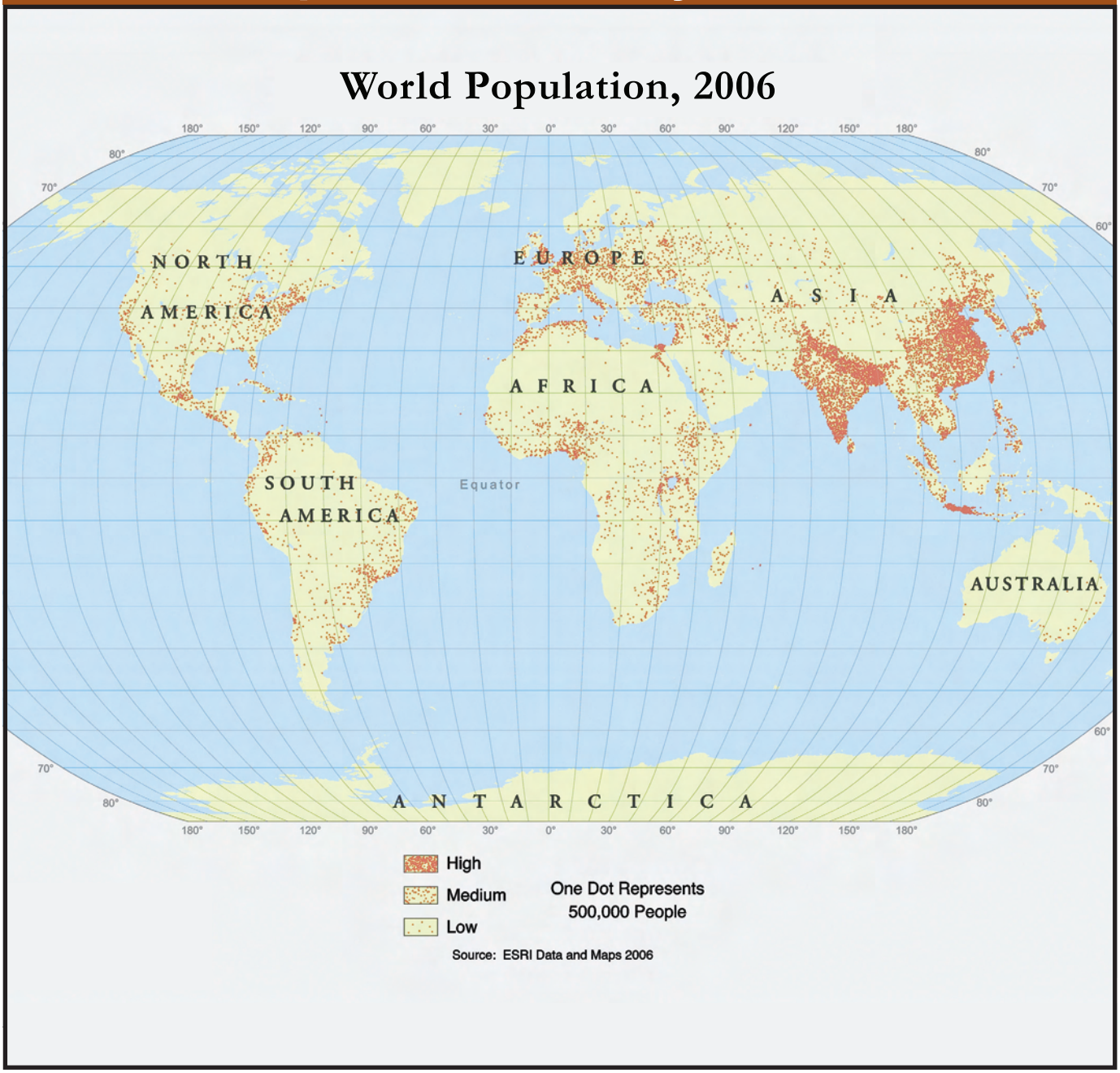
Use **Desert Uses** to respond to the following writing prompt. (5 points)

Describe how a desert ecosystem is important to human lives and communities. Also, identify whether the ecosystem goods and services have local, regional, or global importance.

Rainforest and Desert Goods

Solar and Wind Power from the Desert

Global Population Density



Rainforest Uses

Ecosystems Goods (5 points)

Ecosystems Services (5 points)

Human Uses (5 points)

Desert Uses

Ecosystems Goods (5 points)

Ecosystems Services (5 points)

Human Uses (5 points)

Name: _____

Part 1: Use readings and class discussions to complete the following chart. (18 points)

Biome	Human Practice	Human Intentions	Actual Effect
Rainforest			
Rainforest			
Rainforest			
Desert			
Desert			
Desert			

Name: _____

Part 2: Summary Questions:

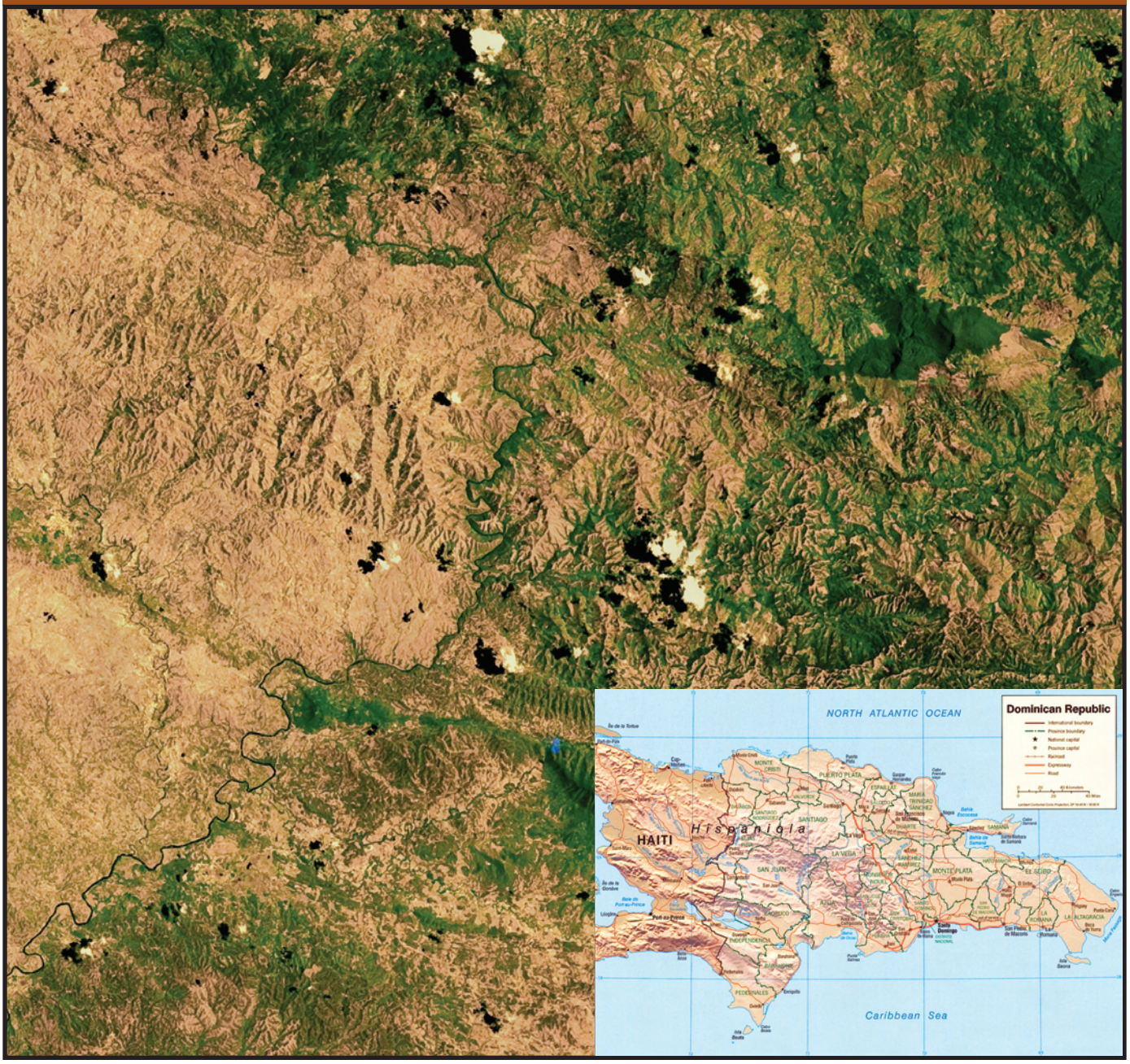
1. Describe a human activity that can influence the local distribution (presence) of desert ecosystems. (5 points)

Name: _____

2. Describe a human activity that can influence the local distribution (presence) of rainforest ecosystems. (5 points)

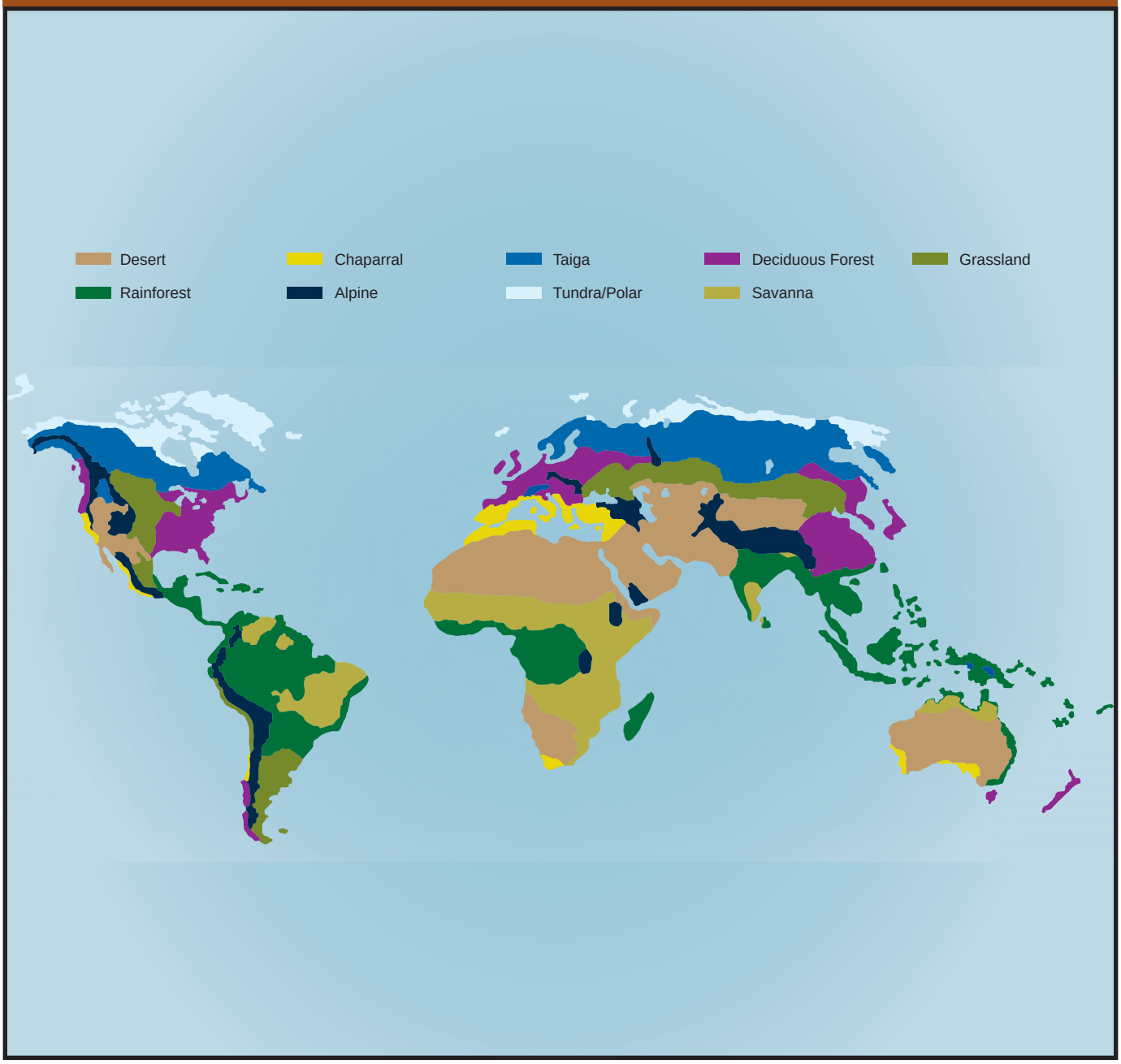
Human Activities in Rainforests

Border Between Haiti and Dominican Republic



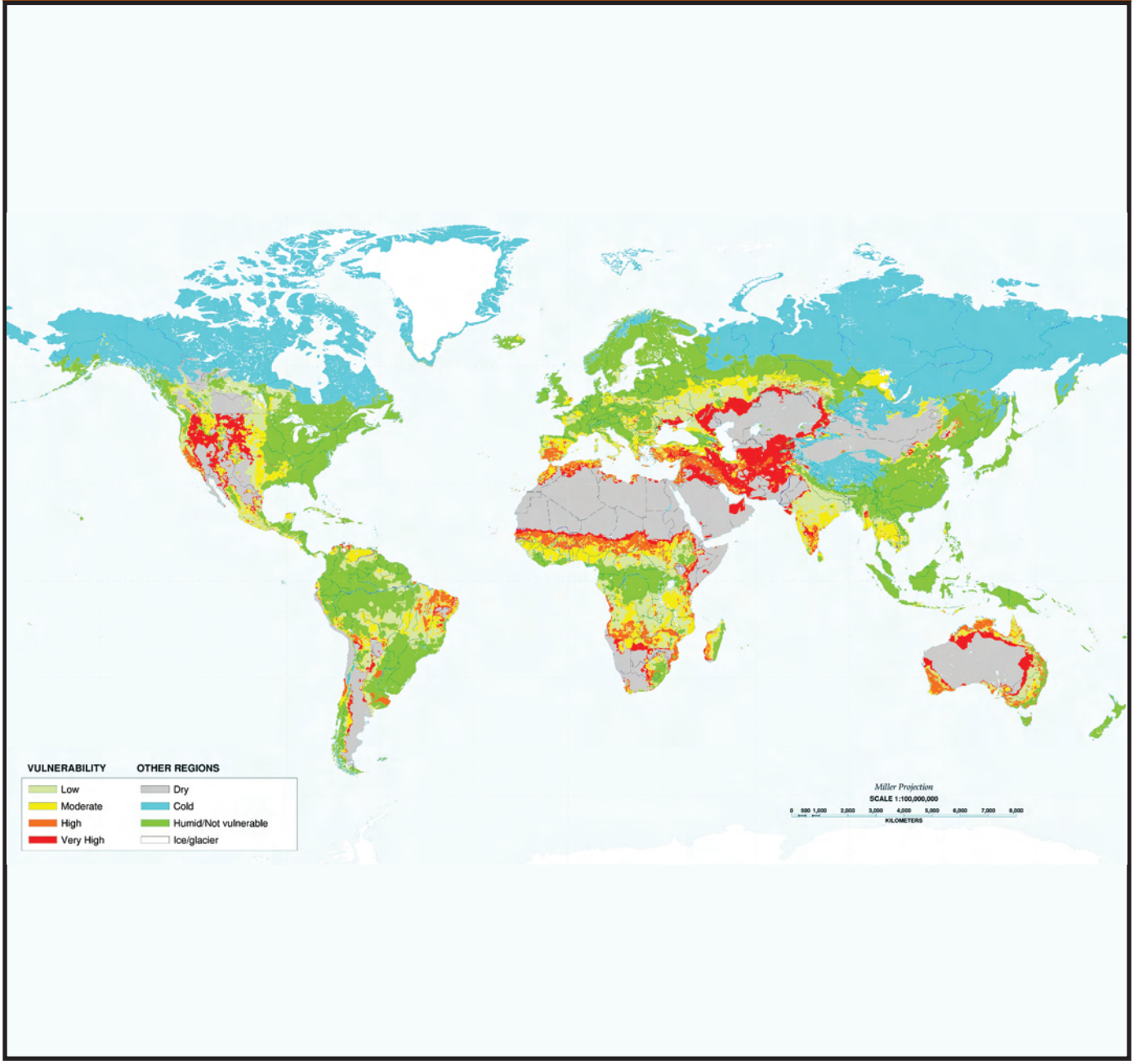
Human Activities in Deserts

World Biomes



Ecosystem Recovery

Global Desertification Vulnerability Map



Global Climate Change—The Green Sahara

Earth has endured many changes throughout geological history that have influenced the geographic distribution of deserts, rainforests, and other biomes. Some changes have resulted in more rainfall in desert areas, changing them to grasslands or even forests.

During the majority of the last 70,000 years, the Sahara has appeared much as it does today, the largest hot desert on Earth. But, about 12,000 years ago, a minor change in the spinning of Earth on its axis caused a major change in the region's climate. This shifting of the planet appears to have caused Africa's seasonal monsoons to move on a track that was slightly to the north of their otherwise "normal" pattern.

As a result of the shifting monsoons, some areas in the Sahara Desert filled with lakes, grasslands, and forests, creating what is known as the "Green Sahara." These areas were rich in vegetation and animals such as hippos, giraffes, crocodiles, and elephants. Eventually, nomadic people "followed" the movement of the animals and vegetation. They began to hunt, harvest, and live in the area.

As global climatic conditions changed over time, the areas of lush vegetation expanded

Camel in Sahara Desert

and then receded, allowing at least two different cultures to occupy the region. About 3,500 years ago, changing climatic conditions began to cause the "Green Sahara" to slowly retreat and revert to the hot and arid conditions that are found in today's Sahara Desert. History is defined as the written record of humans, limiting this record to about 7,000 years. Therefore, to understand more ancient cultures, it is necessary to study clues from archaeological sites. To assess changes in climate, scientists rely on sophisticated methods like analyzing pollen and carbon dating of artifacts to estimate temperature and rainfall dating back tens of thousands of years. Anthropologists have been able to combine these two types of data and compare the timing of changes in ancient climate with records of the successes and failures of ancient cultures.

Skeleton being excavated

Archeologists in the desert

The shifting sands of the Sahara once covered the evidence of the ancient peoples that occupied the Green Sahara. In 2000, a paleontologist looking for dinosaur bones in Niger, in north central Africa, came across a Stone Age burial ground that contained over 200 graves. He discovered two distinct types of people—one type was strong and tall and the other was shorter and less athletic. Patterns on fragments of pottery indicated that the pottery was made by two distinct cultures.

The larger people were called the Kiffian. The Kiffian occupied the Green Sahara about 8, 000 to 10,000 years ago. Near the grave sites archaeologists discovered stone tools, fishhooks carved from bone, and harpoons. Scientific methods dated these tools to the same period as the Kiffian skeletons. Researchers also found the bones of lake-dwelling hippos, crocodiles, and large fish, indicating that these people based their culture on hunting and fishing in lakes and rivers.

The smaller people were named Tenerians, a group that inhabited the area about 4,500 to 6,500 years ago. Stone tools found in the area such as spearheads, knives and pendants indicate that Tenerians were a hunting and gathering culture. Bones of cattle from the same period caused scientists to speculate that the Tenerians may also have been herders with domesticated.

A variety of scientists are continuing to examine the area and the artifacts from these two civilizations. One of the key questions they would like to answer is, "What caused these two cultures to disappear?"

Name: _____

Directions: Answer the following short-answer questions. Discuss the effects of climate change the geographic distribution of biomes and how those changes have affected humans. (5 points each)

1. How were the Kiffian and Tenerian people and cultures different?

2. What planetary and global processes caused the "greening" of the Sahara?

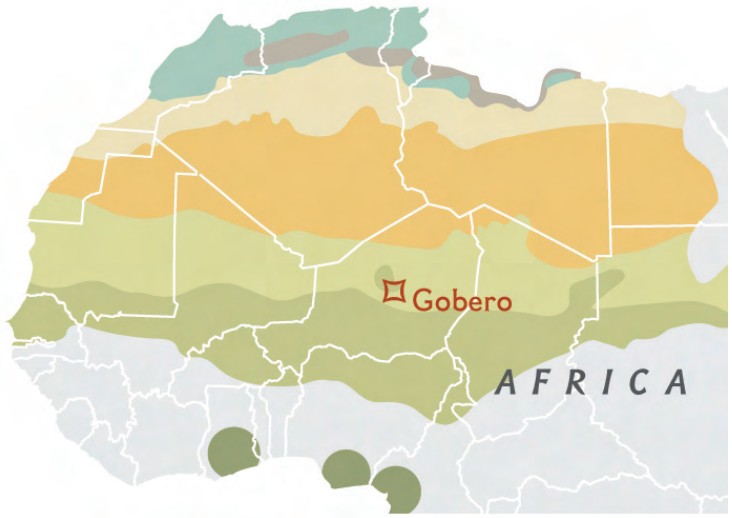
3. How did scientists discover that a drought might have caused the Anasazi to abandon many of their traditional dwelling sites?

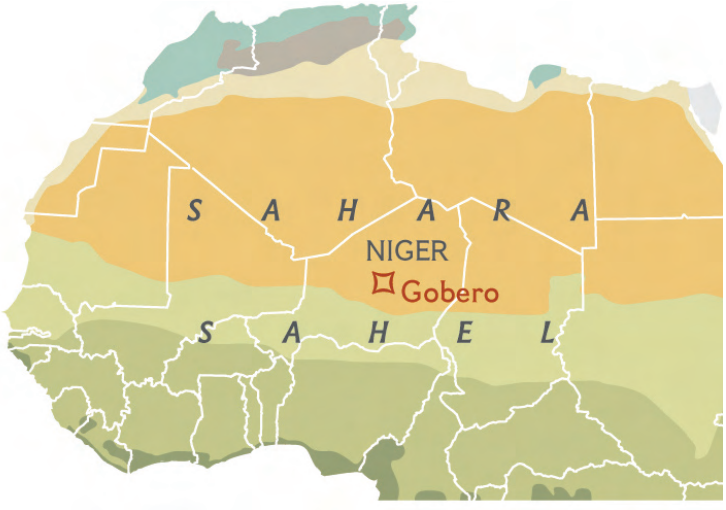
Name: _____

4. What archaeological evidence is there that the populations of the Anasazi had once-flourishing cultures and economies?

5. What local resources might the Anasazi have relied upon?

Changing Boundaries of the Sahara Desert





0 mi 600
0 km 600

Vegetation

- Forest
- Steppe
- Semidesert
- Desert
- Savanna
- Savanna and forest
- Rain forest
- No data

Artifacts of the Kiffian Culture

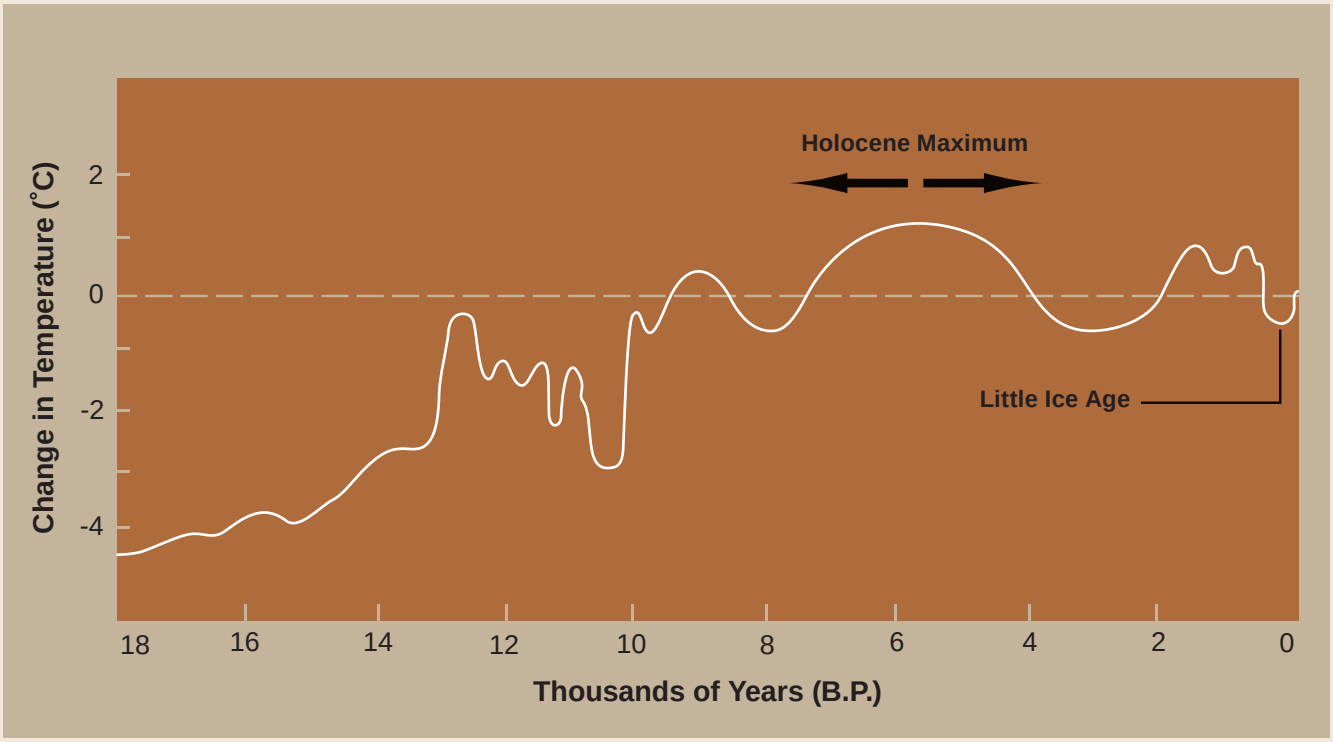
hook tool

microlith

harpoon

harpoon

Global Temperature Change over the Past 18,000 Years



Artifacts of the Tenerian Culture

arrowhead

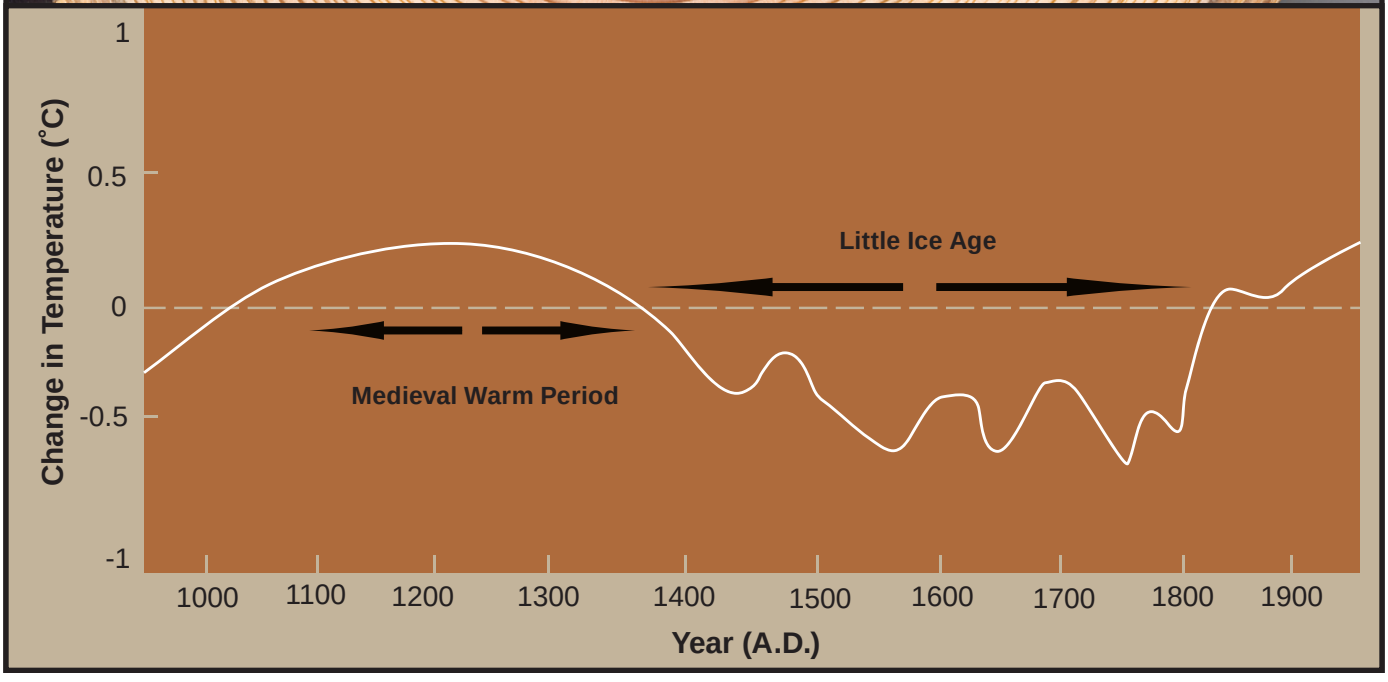
tool from
antelope knuckles

arrowhead

The Anasazi


Utah
Colorado
Virgin Kayenta
Northern San Juan
Kayenta
Chaco
Rio Grande
Arizona
Cibola
New Mexico

Scientific Evidence of Ancient Climates



Recoverability and Vulnerability of Desert Ecosystems

The U.S. Geological Survey (USGS) Recoverability and Vulnerability of Desert Ecosystems (RVDE) project is designed to provide scientific understanding to help conserve and restore threatened desert landscapes. Current research focuses on the Mojave Desert Ecosystem, which is a 125,000-km^2 landscape spread over parts of southern Nevada, western Arizona, southwestern Utah, and southeastern California. It is home to over one million people, including the Nation's fastest growing city, Las Vegas, and is within a day's drive of 40 million people. Many endangered plants and animals depend on the Mojave ecosystem. It contains four national park units, six major military training bases, and a matrix of BLM and privately owned land. Stewards of our public lands are faced with the need to make sound decisions on land use that will allow for economic, recreational, and military use, while still keeping the desert ecosystem healthy and ensuring the survival of threatened species.

USGS scientists are taking an interdisciplinary approach to understanding the physical and biological processes that influence vulnerability of the desert ecosystem to disturbance and its subsequent ability to recover. They are studying historical information, conducting experimental studies on physical and biological processes, and mapping and modeling the existing landscape. These data can be synthesized into maps and predictive models that show how ecosystem components respond to imposed stress, providing valuable tools for desert land managers. Such tools will help land managers make decisions that sustain the desert even as economic, recreation, and military uses continue.

Figure 1. Location of the Mojave Desert Ecosystem (boundary shown in yellow) and the RVDE study area (boundary shown in orange).

Mapping and Modeling Current Conditions

Because vulnerability and recovery times vary across the landscape, RVDE scientists hypothesized that landscape variables such as geology, slope, soil, micro-climate, and botanic habitat must influence how quickly an area bounces back from human impact. Modeling vulnerability and recoverability therefore requires maps of the landscape factors determined to be the most important. Existing geospatial data for the Mojave Desert, such as elevation, roads, hydrography, and Landsat imagery, were collected by the Mojave Desert Ecosystem Program and are available online at www.mojavedata.gov. Starting with these data, RVDE scientists mapped other crucial data sets, such as surficial geology and plant distribution, and modeled various complex landscape characteristics that are spatially and temporally vari-

Figure 2. Land use in the Mojave has included military, mining, grazing, and recreational activities.

able. For example, soil moisture and soil texture are two important physical landscape factors that influence several components of the ecosystem, including vegetation cover and composition, soil compaction and erosion, and biological soil crusts. Hydrologists are working on improved spatial and temporal models of soil moisture and evapotranspiration in the Mojave Desert. Geologists are developing better maps of soil texture by combining maps of surficial geology with soil sample analyses and topography. Maps of evapotranspiration and soil properties can help predict conditions conducive to biological soil crusts, a very fragile and important element of desert ecosystems. Information on current disturbance is also important. For example, RVDE scientists are collecting and analyzing data on recent fire occurrences to better understand fire characteristics in the Mojave Desert. These maps of existing landscape conditions form the base for building vulnerability and recoverability models.

Figure 3. RDVE scientists use wind tunnel experiments to study wind erosion vulnerability.

Understanding the Processes

RVDE scientists are focusing on common impacts and processes that result from a number of different kinds of activities, including disturbance or removal of the vegetation, and disturbances to the soil that result in compaction, destruction of fragile soil crusts, and increased susceptibility to wind erosion. To understand how vegetation recovers, it is necessary to understand

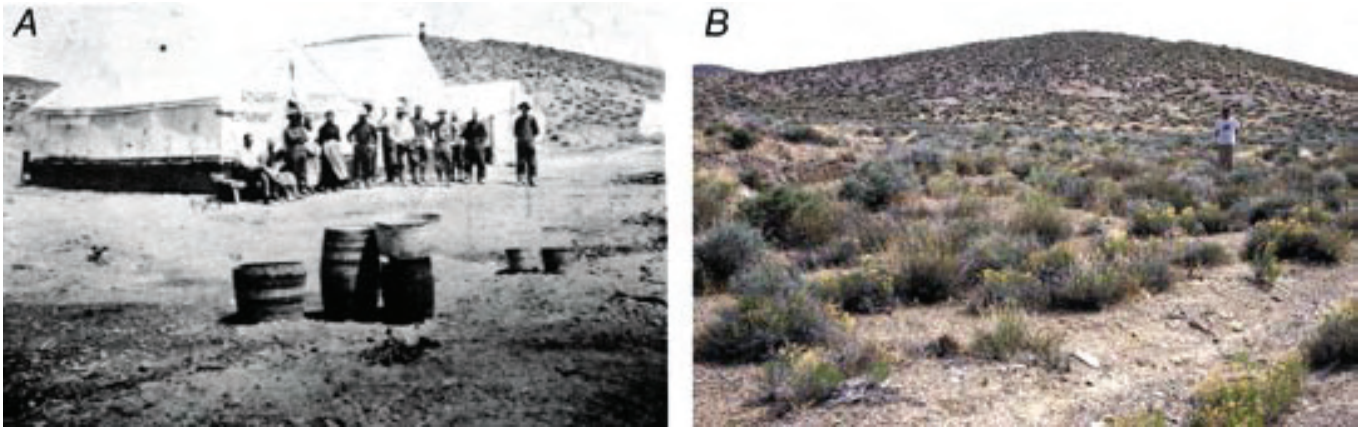


Figure 4. Harrisburg townsite, Panamint Mountains in Death Valley National Park. A, 1908 and B, 1999.

how vegetation changes naturally over time in undisturbed areas of the Mojave. Scientists are also studying vegetation recovery in disturbed areas, both in terms of percent cover and species composition. Vulnerability to soil compaction, recovery from compaction, vulnerability to wind erosion, and time for recovery of soil crusts are all functions of a number of factors, such as soil moisture and soil texture. RVDE scientists use a variety of experimental techniques to determine the functions involved in these processes.

Using the Past to Understand the Present

Some of the once-bustling mining towns that thrived in the Mojave during the early 1900s have vanished with almost complete replacement of vegetation cover, while the sites of other ghost towns are still readily apparent. USGS scientists in the RVDE project are collecting information about conditions in the past to analyze these differences in ecosystem recovery rates and thus better understand how the desert recovers. Analyses of climate history and its influence on vegetation recovery and geomorphic processes, such as overland flow, provide clues as to how vulnerability and recoverability may vary over time. Studies of areas that were disturbed in the past but have since been abandoned, such as military training areas, ghost towns, roads, and utility rights of way, provide useful data on recovery processes and times. Repeat photography is a valuable tool in the analysis of recovery. Data from old maps depicting land use history allow a better understanding of the effect of historical land use patterns on current conditions.

Modeling Vulnerability and Recoverability

To make this research useful to land managers, RVDE scientists are synthesizing this information into spatial models of vulnerability and recoverability. The maps or models of the most relevant landscape factors are combined with knowledge of landscape processes gained from experiments and field studies to derive spatial models of vulnerability and recoverability. Prototype models are being developed for soil compaction (both vulnerability and recoverability), wind erosion vulnerability, soil crust predictions, and vegetation recovery for a part of the Mojave Desert. As these

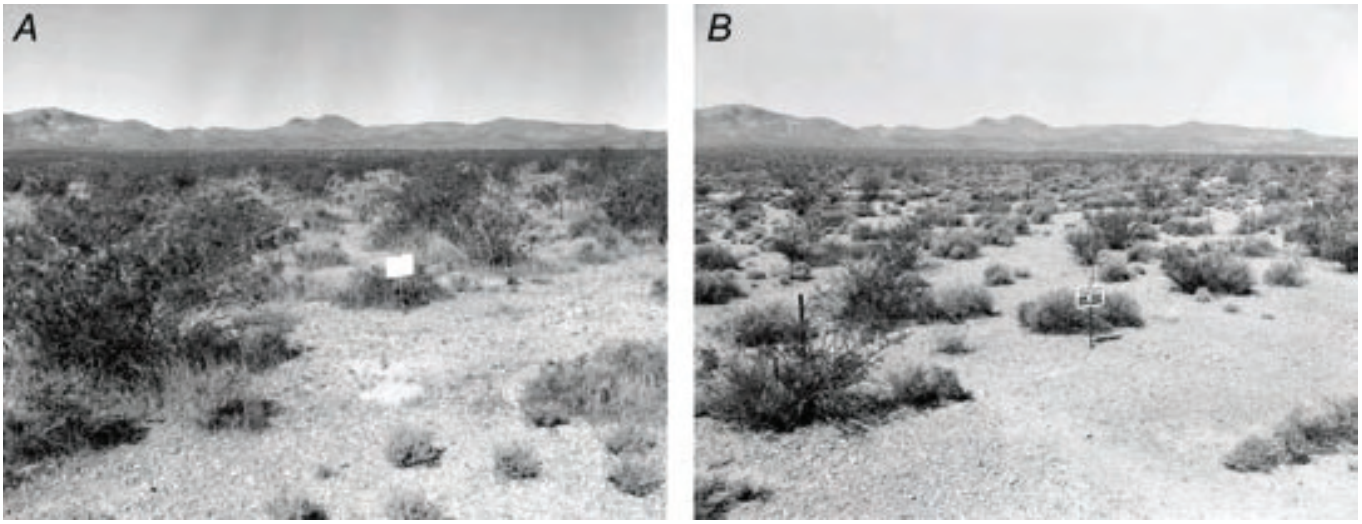


Figure 5. Vegetation plots established in the Nevada Test Site by Dr. Janice Beatley in the 1960s were remeasured by RVDE scientists to study natural vegetation change over time, such as this plot shown in *A*, 1964 and *B*, 2000.

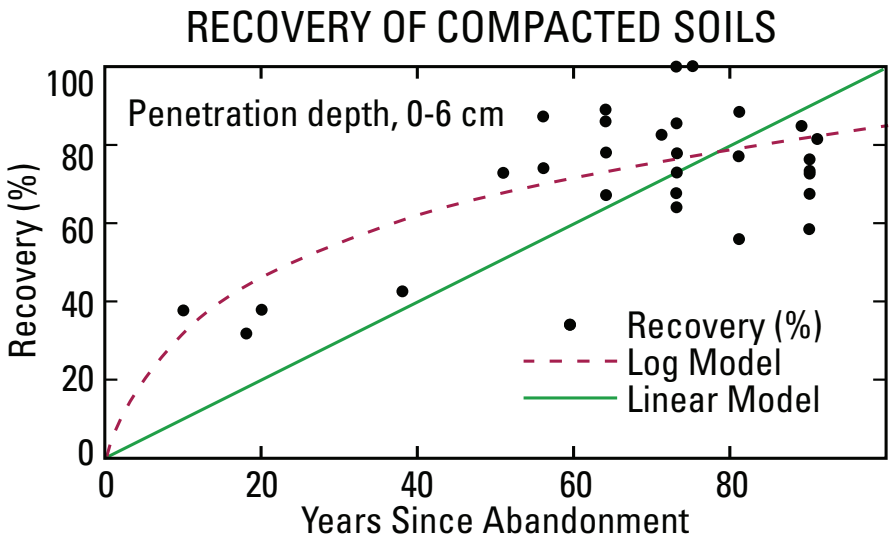


Figure 6. Experimental results showing recovery time from soil compaction.

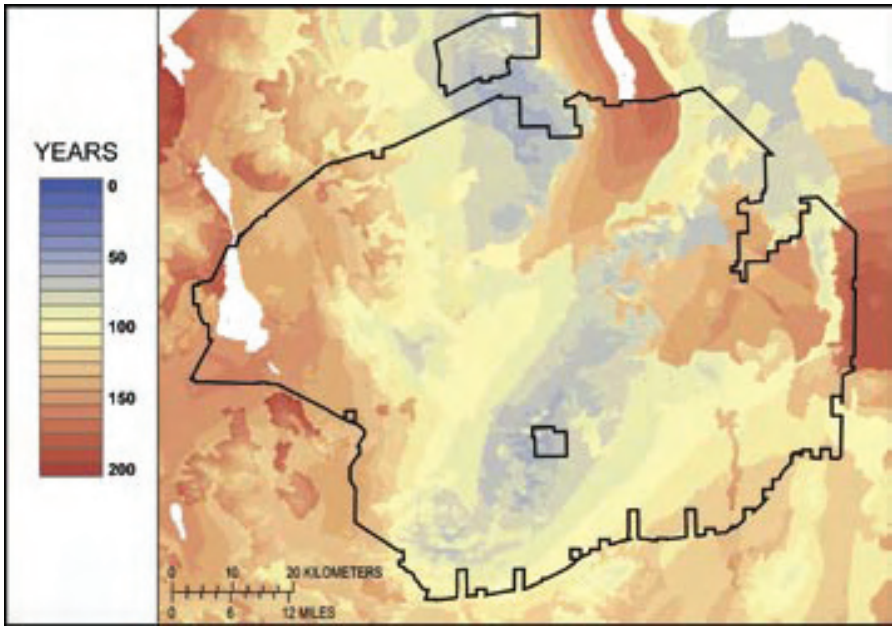


Figure 7. Experimental results such as those shown in the preceding figure on recovery time are translated into geospatial maps showing time to recover from soil compaction.

models are refined and additional models developed, they will be combined into a suite of tools that can be used by land managers to provide input for decision-making. For example, assessing the relative vulnerability of several sites could help in choosing the location and best timing for off-road vehicle use or military activities. Analyzing recovery times in various areas could determine where road closures will be most effective in restoring habitat. Building tools that are based on understanding and modeling the processes rather than developing static maps allows land managers to apply these tools using data of various resolutions in their specific areas of interest.

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Additional information on this project is available at: http://wrg.wr.usgs.gov/mojave/rvde/

For information on other USGS products and services, call 1-888-ASK-USGS or visit the general interest publications Web site on mapping, geography, and related topics at http://mac.usgs.gov/mac/isb/pubs/pubslists/.

For additional information, visit the ask.usgs.gov Web site or the USGS home page at www.usgs.gov.

Name: _____

Directions: Use these questions to guide your reading of Recoverability and Vulnerability of Desert Ecosystems. Provide written responses for each question.

Short Answer Questions (5 points each)

1. What four states contain the Mojave Desert?

2. Name four types of land use decisions land managers make regarding the use of the Mojave Desert.

3. What types of information are scientists collecting to use in making land management decisions?

4. Describe a tool that scientists use to show how ecosystems respond to stress.

5. Identify five or more different factors that scientists study and analyze to make management decisions for desert ecosystems.

6. What common natural and human processes are scientists focusing on in the Mojave Desert? (5 points)

Name: _____

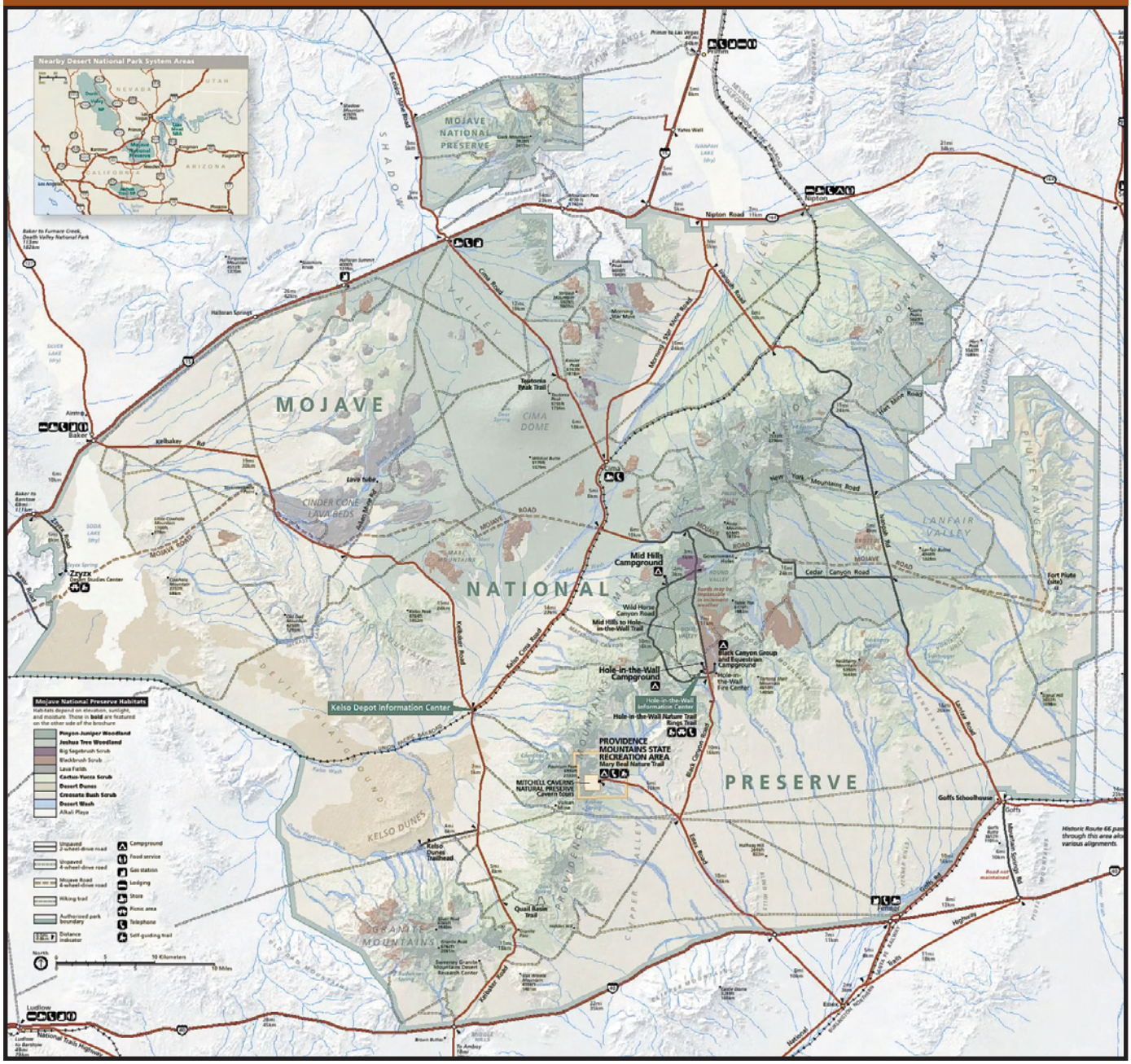
7. How are scientists using research about Mojave Desert ghost towns to make land management decisions?

8. Describe two examples of how scientific data is useful in making land use management decisions about the Mojave Desert.

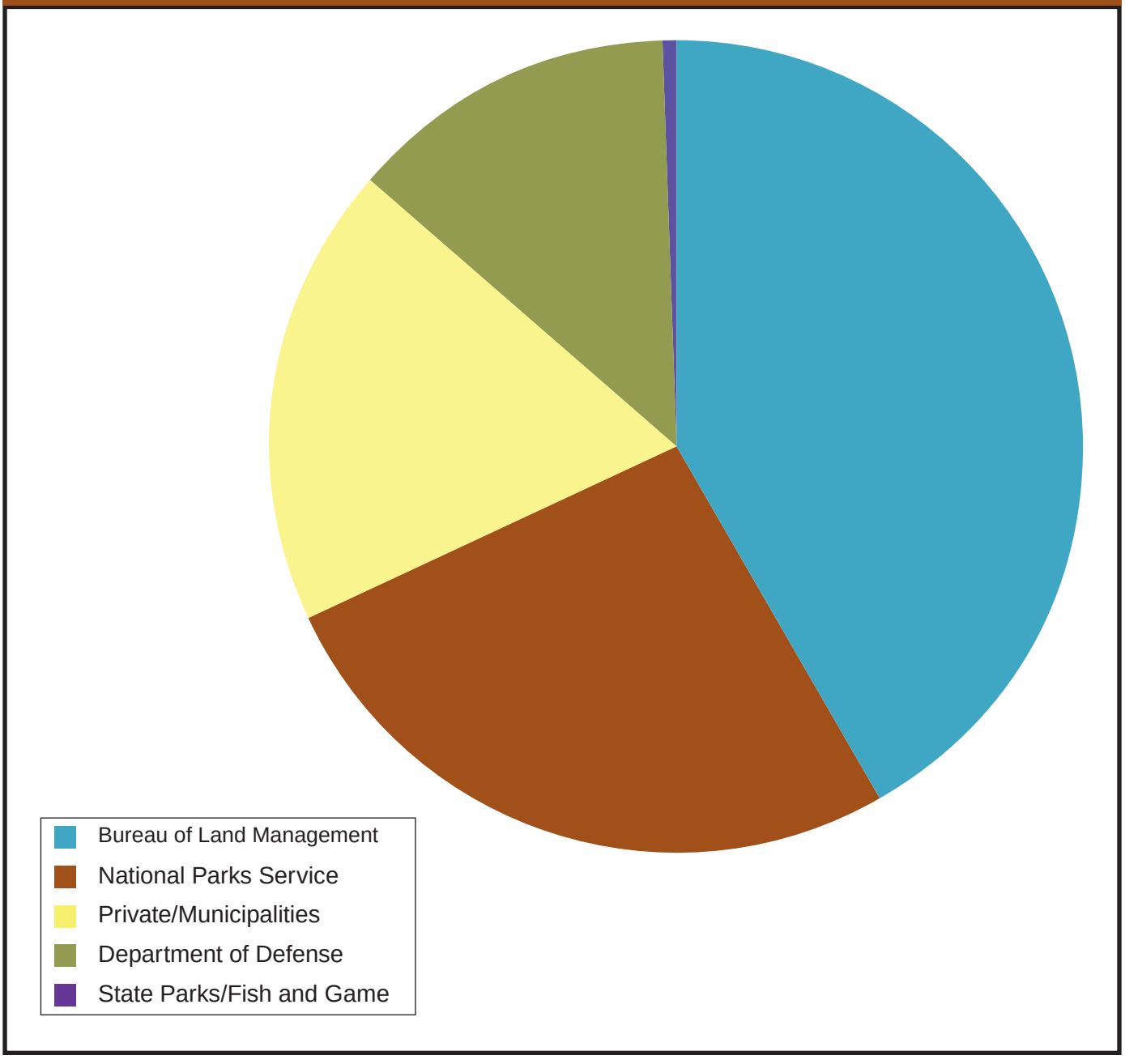
9. Write a two paragraph response to the following prompt: (10 points)
Describe an example of the role of scientific knowledge in making policy and management decisions about human activity related to desert ecosystems.

Name: _____

Mojave Desert Ecosystem

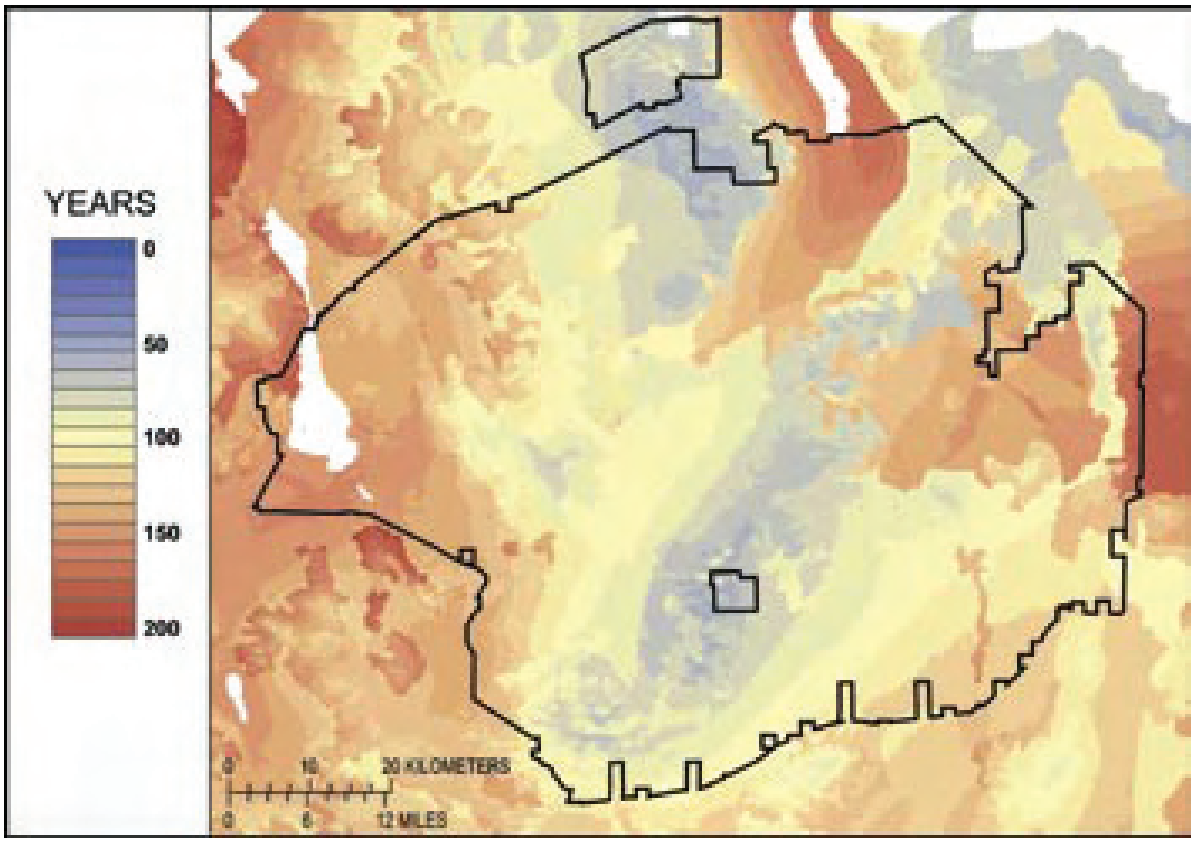


Who Manages California's Mojave Desert Lands?



Desert Crusts

Spatial Map for Soil Compaction Recovery



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